

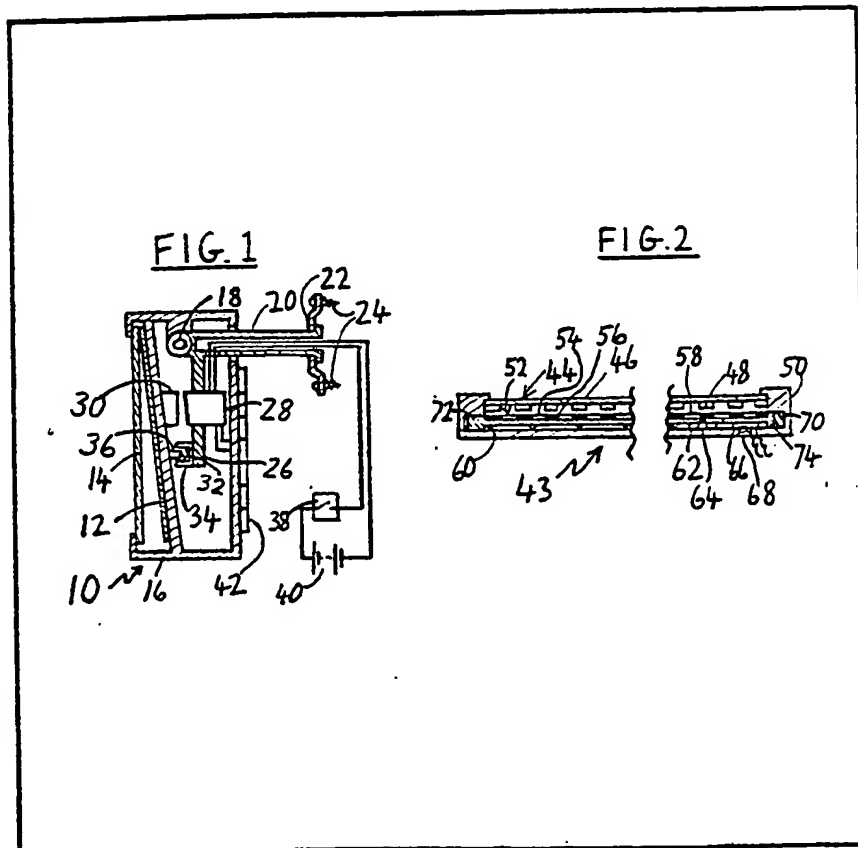
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(54) Mirrors with Control of Reflecting Power

(57) A mirror 12 has its reflecting power controlled otherwise than by manually moving the mirror. The mirror may have remote control, electric operation, solenoid operation 28, relatively moving registering graticules 44, 52 or an electrically controlled effect to alter the reflecting power e.g. by liquid crystal means of

the dynamic scatter or twisted nematic type. There may be provided delay or decay, e.g. by rapid switching, automatic decrease of the on/off ratio and possibly pre-setting thereof. The reflecting power can be changed automatically, e.g. under the control of a directional light-sensitive device. The automatic operation can be enabled manually, by switching on night-lights or automatically in response to ambient light levels.



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FIG. 1

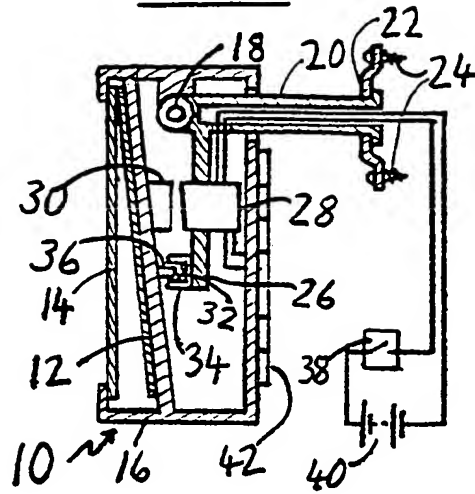


FIG. 2

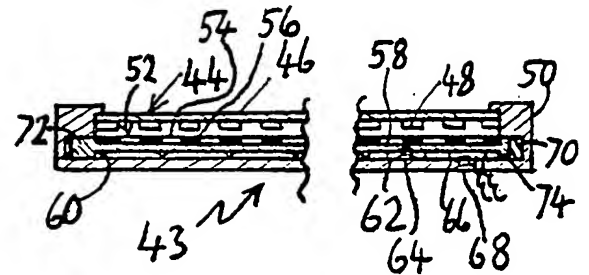


FIG. 3

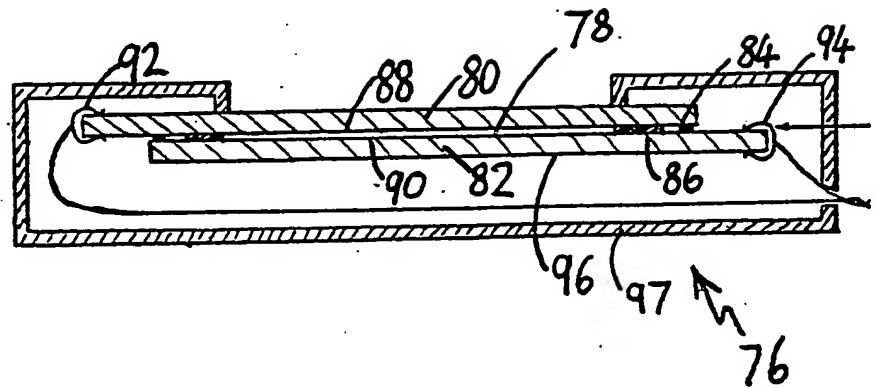


FIG. 4

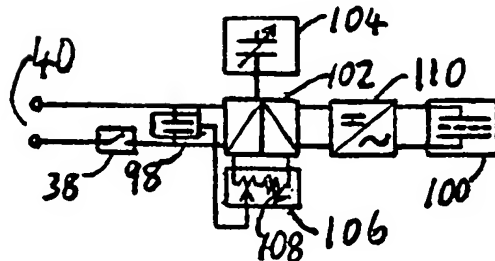
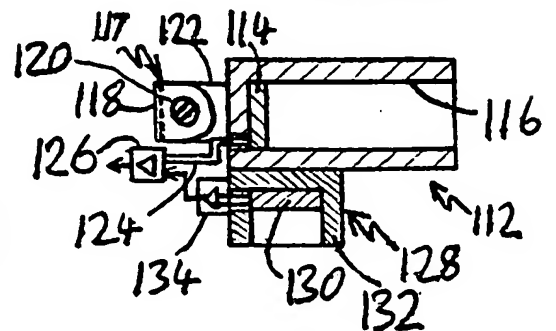


FIG. 5



SPECIFICATION

Mirrors

This invention relates to mirrors.

- In the prior art, in order to control the reflecting power of a mirror, it is known to replace manually one mirror surface by another of different reflecting power. An example is a car rear-view mirror having one substantially fully reflecting surface and another surface angle to the first and of low reflecting power such that the mirror can be manually flicked from a first position in which the fully reflecting surface gives a required view through the rear window to a second position in which the low-reflecting surface replaces the fully reflecting surface and gives a reduced intensity view through the rear window. This is useful during night driving when bright headlights of a following car are suddenly viewed through the rear window tending to dazzle the driver.
- Studies by the applicant have shown that there is room for a significant ergonomic improvement in mirrors and in consequence an unexpectedly large reduction in operator stress and fatigue. With the prior art type of mirror, the driver tends to be lazy and not to reach out to operate the mirror until the level of annoyance (from dazzle due to following headlights) becomes unacceptable. Consequently, particularly on a long night journey, there is eye fatigue caused by the dazzle, which together with the cumulative effect of annoyance contributes to driver stress and fatigue which in turn lead to careless, unsafe and even dangerous driving. Accordingly, the invention provides a mirror that can be controlled as to its reflecting power otherwise than by manually moving the mirror. One may describe such mirrors as "adapted to be power-driven", although the actual amount of power required may be very small in some embodiments and there may not be any movement, as indicated below. The actual amount of energy used by an operator in those cases known to the applicant where it is desired to change the reflecting power of a mirror is very small and the cost of adding a power drive is so high that it is not at all obvious even to want to provide a power drive.

- Examples of ways in which to put the invention into effect include the provision of remote control to operate the mirror between the fully reflecting and low-reflecting conditions. A remote control member, e.g. a switch, for this purpose may be located close to the operator's hand position, e.g. mounted to a steering column. The ergonomic improvement is then such that the operator will voluntarily operate the mirror at a much lower annoyance level, with consequent decrease in stress and eye fatigue. Also, he will not have to take his hands from the controls, e.g. steering wheel, to operate the mirror. Both of these aspects lead to increased safety, e.g. in driving. A particularly convenient, economically viable and practically feasible example of a mirror for this purpose is one adapted for electric operation. The power supply may then be conveniently derived

- from an existing power supply, e.g. of a vehicle, or it may utilise low weight batteries or even a battery of solar cells which does not need replacing and may, for example, be mounted to the back of a housing for the mirror.

- The mirror may be of the prior art kind mentioned above, adapted to the power-operated by the provision of a solenoid device to operate it, between fully reflecting and low-reflecting conditions. This requires a minimum of adaptation of an existing mirror.

- An improved embodiment, which reduces multiple images found with the prior art mirror mentioned and requires less solenoid-actuated movement and drive current for the same is a mirror comprising relatively movable, registering gratitudes.

- A particularly convenient embodiment is obtained by utilising an electrically controlled effect for changing the reflecting power of a stationary reflecting surface. This can provide even more elimination of annoying multiple images than the graticule embodiment, avoids the use of moving parts and can be quicker acting and more versatile. It lends itself to being incorporated in complex systems and in other applications than driving mirrors, e.g. in any optical system where there is required a mirror of variable reflecting power which is easy and quick to make and control. Accordingly, a particular embodiment of the invention provides a mirror that incorporates liquid crystal (LC) means to effect a change in its reflecting power. A distinctive feature of such a liquid crystal mirror (LCM) compared with known liquid crystal displays (LCDs) is the provision of a mirror (i.e. specular reflecting) surface, whereby a reflected image can be seen, rather than merely a contrasting background to an alphanumeric LCD. In one embodiment, an LCM incorporates a layer of dynamic scatter LC in front of a specular reflecting surface. Upon energisation of the LC, there is produced a frosted or misted effect which spreads the glare (e.g. from following headlights in the case of a rear-view mirror) and reduces the (specular) reflecting power (some 75% of the incident light being scattered away from the eye) while still allowing a clear image to be seen (e.g. of the lines on the glass of a following headlight). The spread effect has the advantage of forming a continual reminder that the mirror is in its low-reflecting condition which is conducive to safer driving since persistence of this condition is sometimes forgotten in the case of a prior art mirror leading to less safe driving. When this embodiment is applied in a size of LC suitable for a driving mirror, e.g. of the order of 5cm x 15cm there is upon de-energisation an appreciable decay of frosting, e.g. of the order of one second, which is found restful to the eye.

- Alternatively, the LC may be of the twisted nematic type and the reflecting power of the mirror may be reduced by a polarisation effect found upon actuating the LC. While twisted nematic LC has a rapid response time, e.g. of the order of milliseconds, the decay effect found with

dynamic scatter LC can be simulated electronically (in response to disappearance of *dazzle*) by an appreciable delay, e.g. of the order of one second, or, more nearly and more controllably, by rapid switching (at 10Hz or more) with automatic decrease of the on/off ratio. Set values of the on/off ratio of this LC can also be used in place of a fully "on" condition to obtain smaller reductions in reflecting power. A simple variable control can be used to pre-set the ratio so that the mirror when switched on takes up any desired reflecting power in the range from fully "on" to fully "off". In the case of a twisted nematic LC embodiment, the reduction in reflecting power is effected as a darkening of the field of view and this is more acceptable to some viewers and in some applications particularly where it is desirable to be able to see the background features even when they are dimmed.

In relation to all of the above embodiments, the change in reflecting power can be applied to part or all of the mirror and in the embodiments allowing controllable level of reflecting power the level can be made to differ in different parts of the mirror.

In a preferred way of putting the invention into effect, the change in reflecting power responsive to the incident light exceeding a threshold is made automatic. This can be applied, for example, to any of the above embodiments. Quite apart from the convenience of this, the feature has been found to produce a truly amazing reduction in operator stress, particularly in the case of night driving in which the virtually instantaneous reaction of the mirror to glare from the rear appears to eliminate all annoyance from this source and considerably reduces eye strain which two factors together produce a marked and wholly unexpected reduction in driver stress and fatigue that is especially noticeable after a drive of several hours. In tests, drivers have felt as fresh after several hours of night driving with the automatic mirror as if they had been driving during daylight and in one case the driver after two hours of a night drive with the mirror operating automatically followed by five minutes of driving with the mirror on manual operation refused to drive further unless allowed to use the mirror on automatic operation. An additional advantage of safety in driving arises because it is not necessary to take the hands off the steering wheel and also there is no opportunity for the driver to omit to operate the mirror due to laziness. The latter point also contributes to reduction in stress since the driver is not motivated to operate the mirror by annoyance reaching an unacceptable level. Also, safety is improved because there is no opportunity for the driver to forget to return the mirror to its fully reflecting condition.

A convenient actuating device for automatic operation comprises a directional light sensitive device, e.g. a light sensitive cell provided with a directing hood, e.g. a tubular hood several times longer than its diameter pointing generally

towards the source of light, whereby in the case of a rear-view mirror actuation only occurs in response to dazzling lights at the rear of the vehicle. The decay mentioned above has in an automatic LC embodiment a further distinct advantage in reducing stress in that it reduces the surprise which occurs in switching off since this is not actuated by the operator. The automatic operation when wanted, e.g. at night, can be enabled manually by means of a suitable switch. The light sensitive device can be made quite small and mounted adjacent the mirror or even behind the mirror to view the rear window through a small transparent portion of the mirror surface, e.g. near one edge. It is particularly useful for the device to be adjustably mounted on a fixed mounting for the mirror and adjusted to point towards the rear window. The adjustment is preferably in a plane containing a line from approximately the centre of the rear window to the device and a line from the device to a middle position for a driver's head, since it is found in practice that this single degree of freedom will accommodate most variations between individual drivers and between different conditions for a particular driver.

For a further degree of automatic control, with added convenience, safety and stress reduction, the automatic operation described above can itself be automatically enabled in connection with driving in the dark. For example, the automatic operation can be linked to night lights (usually side lights) of a vehicle so as to be switched on therewith. Alternatively, there can be a second light sensitive device responsive to ambient light to enable the automatic operation when ambient light reduces below a pre-set threshold. This can conveniently be in the form of a light sensitive cell with a shallow tubular hood perhaps shorter than its diameter and perhaps at right angles to the first mentioned light sensitive device so that it can be directed up or down in a vehicle but shaded by its hood from operating in response to the rear dazzle.

While the invention may be applied to a rear-view mirror inside a vehicle, it may equally be applied to a door or wing mirror. It will be appreciated that various features described above permit improved visual flexibility, automatic operation or suitability for conversion to automatic operation with minimum inconvenience, suitability for the control gear to be of small weight and size and provide a low power drain.

Reference will now be made by way of example to the accompanying drawings, in which:—

Figure 1 is a partly schematic representation including a vertical section of a mirror and embodying the invention;

Figure 2 is a horizontal section of another mirror embodying the invention;

Figure 3 is a horizontal section of another mirror embodying the invention;

Figure 4 is a schematic block diagram of a

circuit of another embodiment of the invention;
and

Figure 5 is a schematic representation including a vertical section of a light sensitive device provided in another embodiment of the invention.

Referring to the drawings, Figure 1 illustrates an embodiment of the invention in which a mirror 10 that can be controlled as to its reflecting power otherwise than by manually moving the mirror comprises a fully reflecting surface 12 and, angled to it, a low-reflecting surface 14, which is a plain sheet of glass, both fixed in a housing 16 mounted by a hinge 18 to a hollow support 20 fixed by means of a plate 22 and self-tapping screws 24 to the body (not shown) of a vehicle. A fixed arm 26 of the support 20 carries a solenoid 28 and the housing 16 carries fixedly an armature 30 attracted by the solenoid 28 when energised to move the housing 16 and so bring surface 14 into the position occupied by surface 12 when the solenoid 28 is unenergised. Arm 26 also carries a spring 32 in a cup 34 to co-operate with a plunger 36 carried by housing 16 and return the latter upon de-energisation of solenoid 28. The solenoid is operated by an on/off switch 38 mounted to the steering column (not shown) and interposed in a branch of the vehicle supply 40. Alternatively, the power supply is provided by solar cells 42.

In another embodiment, illustrated in Figure 2, mirror 43 comprises a front graticule 44 consisting of a transparent sheet 46 of glass with a grating of fully or partially reflecting strips 48 that are seen in cross-section in the Figure fixed in a housing 50. A rear graticule 52 consists of a grating formed of alternate fully reflecting strips 54 and non-reflecting strips 56 carried by a sheet 58 provided with slide lugs 60. The graticules are in register so that, in the "fully reflecting condition" shown in Figure 2, there is maximum reflection. An armature 62 is fixed by a bolt 64 to the sheet 58 and co-operates with a solenoid 66 fixed by a bolt 68 to the housing 50 to cause the graticule 52 to slide to the right (as seen in Figure 2) when the solenoid 66 is energised, so that non-reflecting strips 56 are located between strips 48 and the mirror is in its low-reflecting condition. Upon de-energisation of solenoid 66, a spring 70 returns the rear graticule 52 to the "fully reflecting position". The width of the strips 48, 54, 56 may conveniently be of the order of 1mm for use in a mirror 42 about 1/2 metre from the eyes of a driver who, driving at night time and focusing his eyes on a distant rear image, will not notice the individual strips but see a continuous image in the mirror 42. The solenoid-actuated sliding movement is then the width of a strip, i.e. about 1mm. Plunger ends 72, 74 of sheet 58 move in recesses in housing 50 to guide movement of graticule 52.

In an embodiment of the invention illustrated in Figure 3, a mirror 76 incorporates LC means to effect a change in its reflecting power. An LC layer 78 is retained between a front plate 80 and a rear

plate 82 of glass or plastic by an edge seal 84 and has a thickness determined by spacers 86.

Surfaces 88, 90 are electrically conductive and alternating voltage is applied between them to actuate the LC layer 78. For this purpose, they are brought out to clips 92, 94 or edge connectors (not shown). Conductive layer 88 is transparent and may suitably be of tin oxide. Layer 90 may likewise be transparent and of tin oxide when there is a specular reflecting surface 96 at the back of plate 82. Alternatively, conductive surface 90 may itself be specularly reflecting and of e.g. tin or silver. The whole arrangement is fixed inside a housing 97 which may also contain the electronic drive circuitry and perhaps a power supply battery, though the latter may be in the form of solar cells or derived from the vehicle power supply, as indicated above. An actuating control member may also be provided as indicated by 38 above. The LC may be of the dynamic scatter type with the effects described above, this being actuated by an applied voltage of between 20 and 60 volts. Alternatively, the plate 80 may be polarised and the LC layer 78 of the twisted nematic type which polarises upon actuation, e.g. by a voltage between two volts and 20 volts, with the effects noted earlier in this specification.

There may be provided a drive circuit as illustrated schematically in Figure 4. A power supply 40 is connected through an on/off control switch 38 to a delay/decay element 98 for controlling switch-off of the LCM 100. The supply then feeds an astable circuit 102 provided with a control 104 for its frequency and a control 106 for its on/off ratio. Element 98 governs control 106 as to the delay and/or shape of decay of switch-off of LCM 100. An adjustable member 108 in the control 106 allows presetting of the on/off ratio and hence the level of reflecting power when the LCM 100 is in its "on" condition. The astable circuit 102 in turn feeds a DC to AC converter and amplifier 110 which drives LCM 100.

In an automatic embodiment, having the effects mentioned earlier in this specification, there is provided, as illustrated in Figure 5, a first light sensitive device 112 comprising a photo resistive or photo emissive cell 114 provided with a tubular hood 116 which may, for example have a length of 8mm and a diameter of 2mm, or different dimensions in about the same ratio. The device is provided with mounting means 117 comprising a circular strip 118, for encircling a fixed support, such as 20 (Figure 1), hinged by a tightening bolt 120 to a blade 122 to which the device 112 is fixed. The bolt 120 can be loosened and tightened to allow adjustment of device 112 in the plane mentioned above. Leads 124 of device 112 can be connected (through a threshold amplifier 126) in place of switch 38 to provide automatic operation of the circuit shown in Figure 4 when device 112 is pointed towards the rear of a vehicle. The level of dazzle at which device 112 operates the Figure 4 circuit can be

pre-set by adjusting the threshold of amplifier 126. Amplifier 126 can be switched on and off manually or by connecting it to a night light switch, or as will now be described (which was mentioned above).

- 5 In a further embodiment mentioned above, a second light sensitive device 128 comprising a photo resistive or photo emissive cell 130 provided with a shallow hood 132 directed at right angles to hood 116 and acting through its own threshold amplifier 134 to enable or disable amplifier 126 in response to reduction in the ambient light below a level which can be pre-set by adjusting the threshold of amplifier 134. Hood 132 is 1 mm long and 2mm in diameter, or in like proportion.

The term "fully reflecting" used herein refers to the fully reflecting power of which the embodiment is capable as set.

- 20 This specification also contemplates any workable combination of any of the features mentioned above.

- 25 The specification contemplates as inventions any inventive feature or inventive combination of features referred to above.

Claims

1. A mirror that can be controlled as to its reflecting power otherwise than by manually moving the mirror.
- 30 2. A mirror as claimed in claim 1, comprising a remote control to operate the mirror between fully reflecting and low-reflecting conditions.
3. A mirror as claimed in claim 1 or 2, adapted for electric operation between fully reflecting and low-reflecting conditions.
- 35 4. A mirror as claimed in any preceding claim, comprising a solenoid to operate it between fully reflecting and low-reflecting conditions.
5. A mirror as claimed in any preceding claim, comprising relatively movable, registering gratitudes.
6. A mirror as claimed in any one of claims 1 to 3, adapted to utilise an electrically controlled effect to change the reflecting power of a stationary reflecting surface of the mirror.
- 45 7. A mirror as claimed in claim 6, that incorporates liquid crystal means to effect a change in its reflecting power.
8. A mirror as claimed in claim 7, in which the liquid crystal means comprise dynamic scatter liquid crystal.
- 50 9. A mirror as claimed in claim 7, in which the liquid crystal means comprise twisted nematic liquid crystal.
10. A mirror as claimed in claim 7, 8 or 9, incorporating an appreciable delay or decay.
- 55 11. A mirror as claimed in claim 9 or 10 comprising twisted nematic liquid crystal, provided with means for rapid switching of the latter.
- 60 12. A mirror as claimed in claim 11, comprising means for automatically decreasing the on/off ratio of the rapid switching.
13. A mirror as claimed in claim 11 or 12, provided with means to pre-set the on/off ratio of the rapid switching.
- 65 14. A mirror as claimed in any preceding claim, comprising means to effect a change in its reflecting power automatically in response to the incident light exceeding a threshold.
- 70 15. A mirror as claimed in claim 14, in which an actuating device for the automatic operation comprises a directional light sensitive device.
16. A mirror as claimed in claim 14 or 15, comprising means for automatically enabling the automatic operation.
- 75 17. A mirror as claimed in claim 16, in which means for enabling the automatic operation comprise a device responsive to ambient light.
- 80 18. A mirror substantially according to any embodiment hereinbefore described or referred to.